## Summary and Conclusions

1. The chief indication for short wave diathermy is the presence of inflammation.

2. The chief contraindication for short wave diathermy is edema.

3. This indication and contraindication are inseparably joined together; therefore a relative limitation upon intensity input is always present.

4. The desired physiologic effect from short wave diathermy is the establishment and maintenance of an active hyperemia.

5. The depth heating characteristic of short wave diathermy is of singular advantage, but nevertheless we may be guided in its application by the general rules governing the use of the simple, effective therapeutic agent, namely, heat.

6. The tolerance of inflammatory tissue for heat is always less than that of normal tissue; therefore the tolerance of normal tissue for heat is an unreliable and unsafe guide for determining the power input per unit tissue volume.

7. When optimal technic is employed, the incidence of sweating is a reliable guide for judging the power input per unit tissue volume.

8. A high frequency wattmeter is a valuable aid in determining total power input, but it can not be considered a "dose meter" on account of the presence of undeterminable variables which must be evaluated by clinical judgment.

9. Optimal dosage is the smallest power input per unit tissue volume which will establish and maintain an active hyperemia, the application of which must endure for such time and be repeated at such intervals as are necessary to produce an accumulative beneficial effect.

10. Optimal dosage is determined by the power input per unit tissue volume, and the period of application and of re-application.

11. To produce a physiologic effect the power input per unit tissue volume should be no greater than that required to establish and maintain active hyperemia.

12. The greatest danger of short wave diathermy is overheating; therefore its occurrence should be avoided.

13. Insulation against loss of heat and distribution of the electrical input permit the maintenance of the desired local hyperemia with a minimal electrical input per unit tissue volume and prevent excessive heating of the pathologic zone.

14. Distribution of the power input to the tissues beyond the pathologic zone is of advantage in overcoming associated pathologic and trophic disturbances in contiguous tissues.

15. When an optimal power input to the pathologic zone is employed, there is no contraindication to the maintenance of a continuous or continual active hyperemia by the application of short wave diathermy.

16. For prolonged and frequent applications of short wave diathermy the electromagnetic induction field is the method of choice because of its physical adaptability to secure desired distribution of the power input, its applicability to all anatomic parts, and its established heating characteristics.

Short wave diathermy is a most valuable aid in promoting physical recovery of tissues, and when optimal dosage is employed it is in fact a remedial agent for the process of inflammation.

Optimal dosage is determined by a knowledge of the nature of the pathologic process under treatment, the regulation and performance of the diathermy apparatus, and the experience gained from successful treatments; all these properly balanced formulate the only reliable "dose meter," namely, expert clinical judgment for the determination of optimal dosage of short wave diathermy.

4013 N. Milwaukee Avenue.

Printed in U.S.A.

---

*Reprinted from the Archives of Physical Therapy*
*December, 1940, Vol. XXI, pp. 716-728.*

# OPTIMAL DOSAGE IN SHORT WAVE DIATHERMY *

**MILTON G. SCHMITT, M.D.**

Clinical Assistant, Department of Physical Therapy Northwestern University Medical School
Director of Physical Therapy, Garfield Park Community and Lutheran Deaconess Hospitals

CHICAGO

Short wave diathermy is one of the most valuable aids in physical medicine. Conventional practice accepts it as satisfactory treatment wherever deep heat is indicated; that certain established contraindications must be regarded; that the tolerance of the tissues for heat is a guide for intensity input; and that treatment be repeated as often as clinically "indicated." This "indication" often is a matter of arbitrary decision or economic convenience.

Short wave diathermy has been long regarded by critics as a practice governed by empiricism. By a thorough consideration of the indications, contraindications, and the conditions determining optimal dosage, the conclusion may be reached that short wave diathermy can be accepted not only as an aid but as a definite remedial agent for the process of physical recovery.

Short wave diathermy has been used by me in the treatment of a wide variety of acute and chronic pathologic conditions. Up to the present, 27,676 treatments have been given by me with the application of the determinants of optimal dosage as discussed in this paper. The following illustrative cases are briefly reviewed as typical of results obtained by this method. This clinical study demonstrates the chief indications for, and contraindications to, short wave diathermy.

## Case Reports

Case 1684. — Mrs. S. W., aged 59, diagnosed as carbuncle of neck. This infection was present for two and one-half weeks before short wave therapy was instituted. In spite of the continued application of moist heat the lesion became progressively worse, fever remained high, toxicity and pain were severe. The treatment essentially consisted of the application of an electromagnetic field, applied with a 12-inch disc, low intensity, twenty minutes every hour, twenty-four hours per day for fourteen days, then twelve hours for each of the remaining five days. The only other treatment was superficial dressings. Severe pain was alleviated after the first, and disappeared altogether after the third session. General symptoms of fever, rapid pulse, and the like subsided promptly. Complete sloughing occurred by the thirteenth day; granulations appeared on the fourteenth day and were completed to a level with the skin margins on the nineteenth day. Subsequent epithelization was accomplished with careful dressings of overlapping narrow strips of adhesive tape during a period of six weeks. Total period of hospitalization was nineteen days (fig. 1)

Other carbuncles of equal severity have been treated in like manner and with equally good results. The location of these has been over the scapula, the buttocks, and the groin. Some of these patients had diabetes.

Case 1964. — Mr. M. L., aged 26, was diagnosed after admission as cellulitis of the face with threatening meningitis. The infection began nine days before diathermy was instituted. The symptoms became progressively worse during that time in spite of the application of hot wet dressings. During the 24-hour period before diathermy was ordered the patient began to show signs of meningeal irritation. He had a continued high septic fever and was severely toxic. Treatment was given by the electromagnetic field with a 12-inch disc, low intensity, twenty minutes every hour, day and night for five days, then twelve hours per day for three days. A slight dermal incision was made prior to the initiation of this therapy. The symptoms of severe toxemia and signs of meningeal irritation subsided during the first twenty-four hours. The swelling began to disappear promptly and cleared up early the fifth day. Treatment was continued for three days after the appearance of a persistent normal temperature (fig. 2).

---

* Read before the Eighteenth Annual Meeting of the American Academy of Physical Medicine, Richmond, Virginia, April 25, 1940.

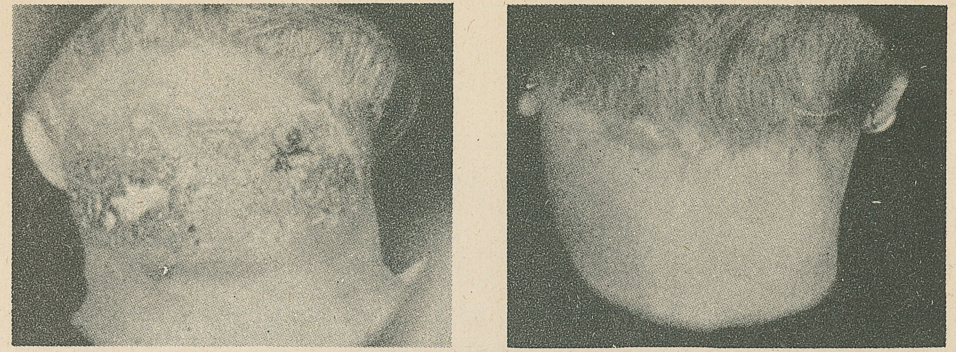


Fig. 1. — *A*, appearance of lesion at beginning of diathermy management; *B*, end-result, six weeks later.

Case 362. — Mr. J. P., aged 58, entered with a diagnosis of infected hand with lymphangitis and axillary adenopathy. This hand was treated in a conventional manner, first with a simple drainage at site of entry. The lesion progressed very slowly for one week, during the next two weeks hot wet dressings were applied to the hand and forearm about sixteen hours per day. At the end of the third week, the lymphangitis and adenopathy suddenly appeared and were ushered in by chills and fever. At this time treatment by electromagnetic induction was instituted, with the application of a long double loop cable extending from the hand to the shoulder. The electromagnetic field was applied twenty minutes every hour day and night for four days, then twelve hours each of the following three days. The fever, the lymphangitis and axillary lymphadenopathy subsided at the end of the first twenty-four hour period. The photographs show the progress. Healing was completed at the beginning of the sixth day. A few weeks later it was discovered that this patient had a blood sugar content of 352 mg., which might explain the failure of recovery during the first few weeks with conventional management, but it is of special interest to observe the prompt recovery effected by the short wave method under the same conditions (fig. 3).

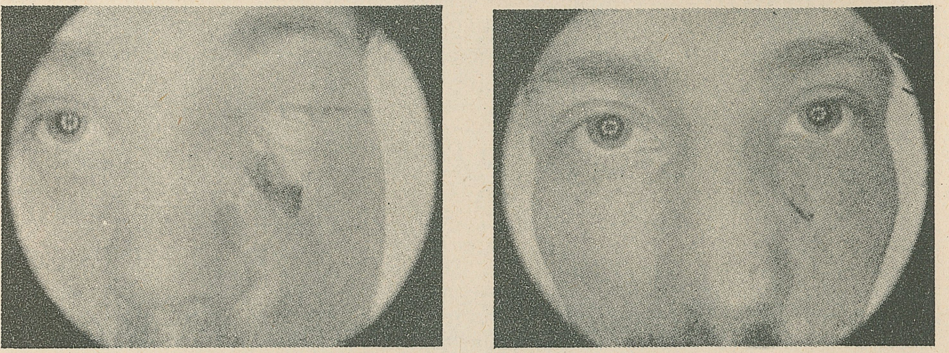


Fig. 2. — *A*, cellulitis of face as it appeared at the beginning of diathermy management; *B*, complete recovery observed on the fifth day.

Case 627. — Mr. F. R., aged 36, was admitted for non-union of the tibia and fibula of nine months duration. During that period the patient had quite adequate care. He had no constitutional disease. In spite of a negative Wassermann report, a course of neosalvarsan was given augmented by 24 injections of calcium, parathyroid extract and viosterol. There was no apparent reason for the non-union. At the tenth month, short wave diathermy was started. At first two 2-hour treatments were given daily; the patient remained ambulatory on crutches. After two and one-half weeks he chose to have but one treatment daily. No other therapy other than good immobilization was administered. He was given a total of 82 two-hour treatments in 69 days. The progress and result are shown in the illustrations. At the end of this time the patient was bearing full weight on the leg and using only a cane for assistance (fig. 4).

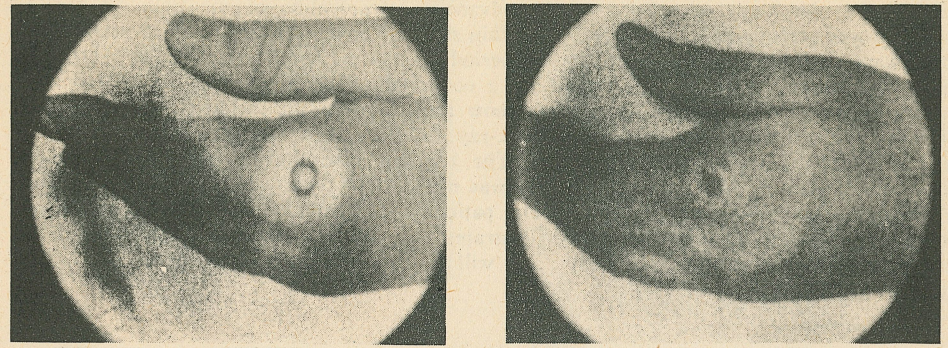


Fig. 3. — *A*, appearance of lesion at beginning of diathermy management; *B*, completely healed on the sixth day.

Case 1709. — Master C. S., aged 9, was eventually diagnosed as osteomyelitis of the tibia. The patient entered the hospital complaining of severe pain in the leg. No local signs of inflammation were evident and the x-ray was negative. Short wave diathermy was given with a low intensity for thirty minutes daily. After ten days a subperiosteal abscess

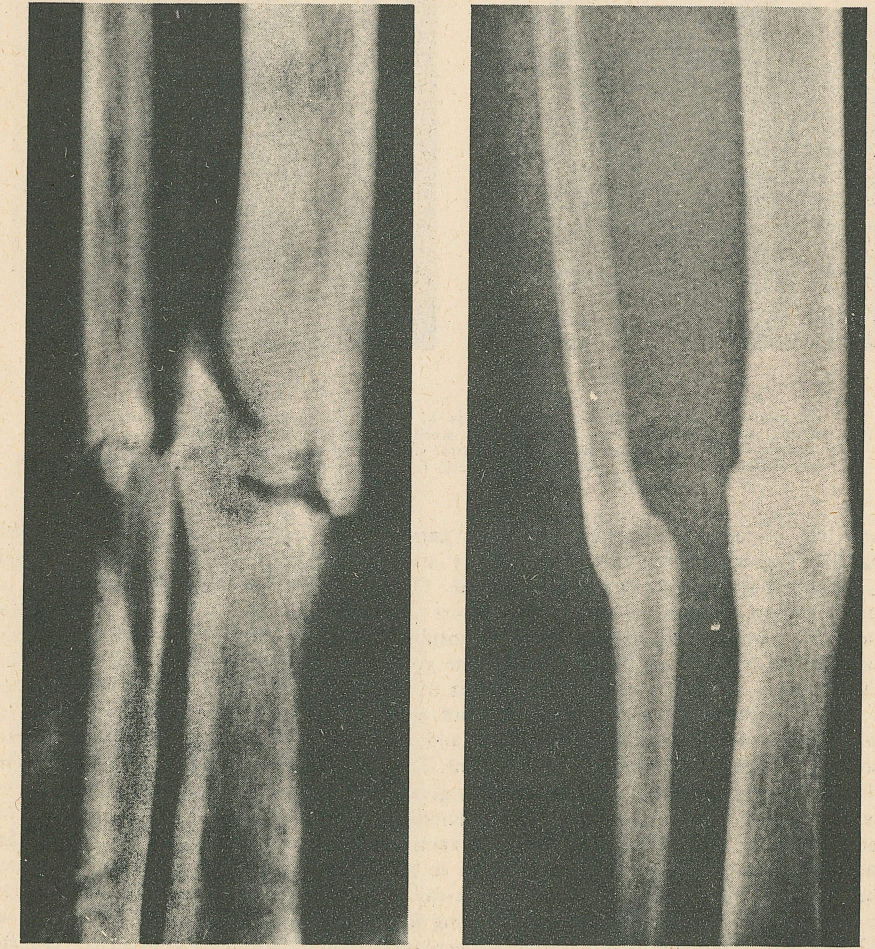


Fig. 4. — *A*, tibia and fibula after non-union of nine months standing; *B*, complete union after ten weeks of diathermy management.

localized and was opened and drained. The diathermy was continued as before. On the thirtieth day the x-ray revealed a severe advanced osteomyelitis of the tibia. A radical operation was performed leaving only a very thin shaft of bone with the attached periosteum. Short wave diathermy in the postoperative period was given for thirty minutes every two hours, six treatments daily, thus producing a continual active hyperemia for twelve consecutive hours daily. The roentgenograms show the progress. At the fifth month the boy fell and sustained a fracture as seen in the x-ray; the nature of this fracture indicated the hard quality of the new bone formation. The leg was placed in a cast for one month during which time no short wave diathermy was used. After removal of the cast treatment by diathermy was instituted as before. The patient had a total of five months' treatment during a six month period. This case illustrates the value of short wave diathermy in promoting a rapid osteogenesis. Only time will tell the ultimate effect upon the osteomyelitis toward a cure (fig. 5).

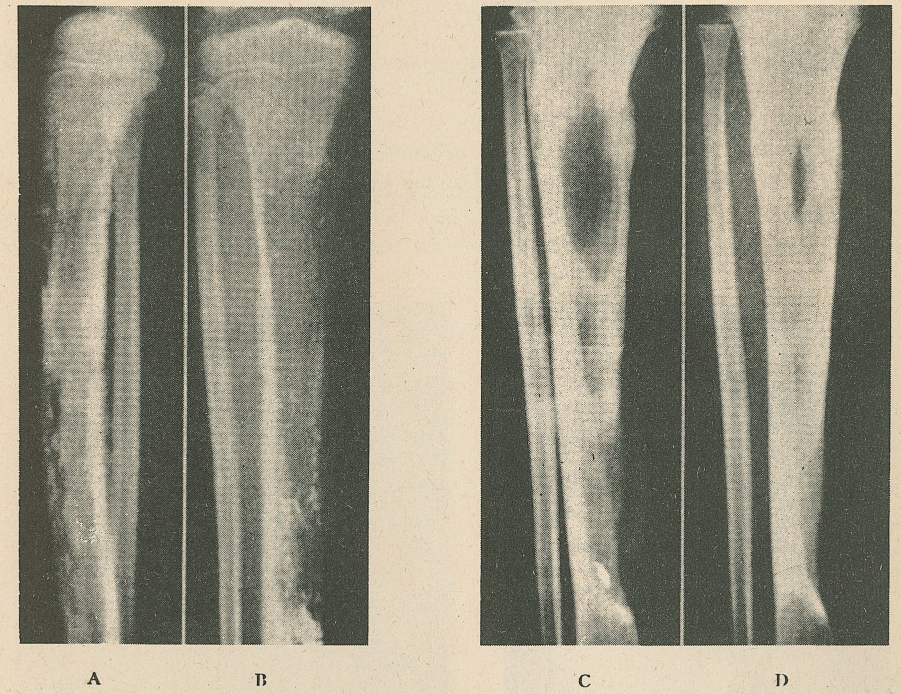


Fig. 5. — *A*, diagnostic x-ray showing osteomyelitis of tibia; *B*, appearance of tibia after radical surgical removal of infected bone; *C*, after eight weeks treatment with electromagnetic induction. Note rapid filling in and the appearance of structural markings in the new bone; *D*, after twenty-four weeks of treatment with electromagnetic field, regeneration of bone completed.

Case 1669. — Miss M. K., aged 25. This patient was very sick for five days before entering the hospital. The fever and toxicity and respiratory symptoms indicated pneumonia, but the physical findings were atypical. On the sixth day the patient coughed up fourteen ounces of exudate in twenty-four hours A clinical diagnosis of lung abscess was made and the patient was brought to the hospital. This exudate was reported by the pathologist to be typical lung abscess fluid. The volume of exudate produced continued for days. X-ray study did not support the diagnosis of abscess, no cavity could be demonstrated at any time and the solid shaded area did not seem to conform to that usually seen in abscesses. Diagnosis of interlobar empyema, and pulmonary infarct, were also suggested. An associated pneumonic congestion was evident. Two days after the diagnostic x-rays, short wave diathermy was instituted. Treatment was given 20 minutes per hour twenty-four hours per day for twenty consecutive days. The pulmonary distress was markedly relieved after the first day. After several days the severe toxemia abated and the volume of the exudate decreased definitely. The temperature dropped to normal on the seventh day and remained so. The treatment was continued until the x-ray no longer showed any decrease in the densely shaded area in the upper chest. So long as this shaded area decreased in size we believed that the treatment was causing a decrease of an inflammatory process. On the tenth day lipiodol was instilled into the opposite lung but no evidence of bronchiectasis was discovered to account for the volume of exudate produced earlier. The chest was checked by x-ray six months later and found to be entirely negative (fig. 6).

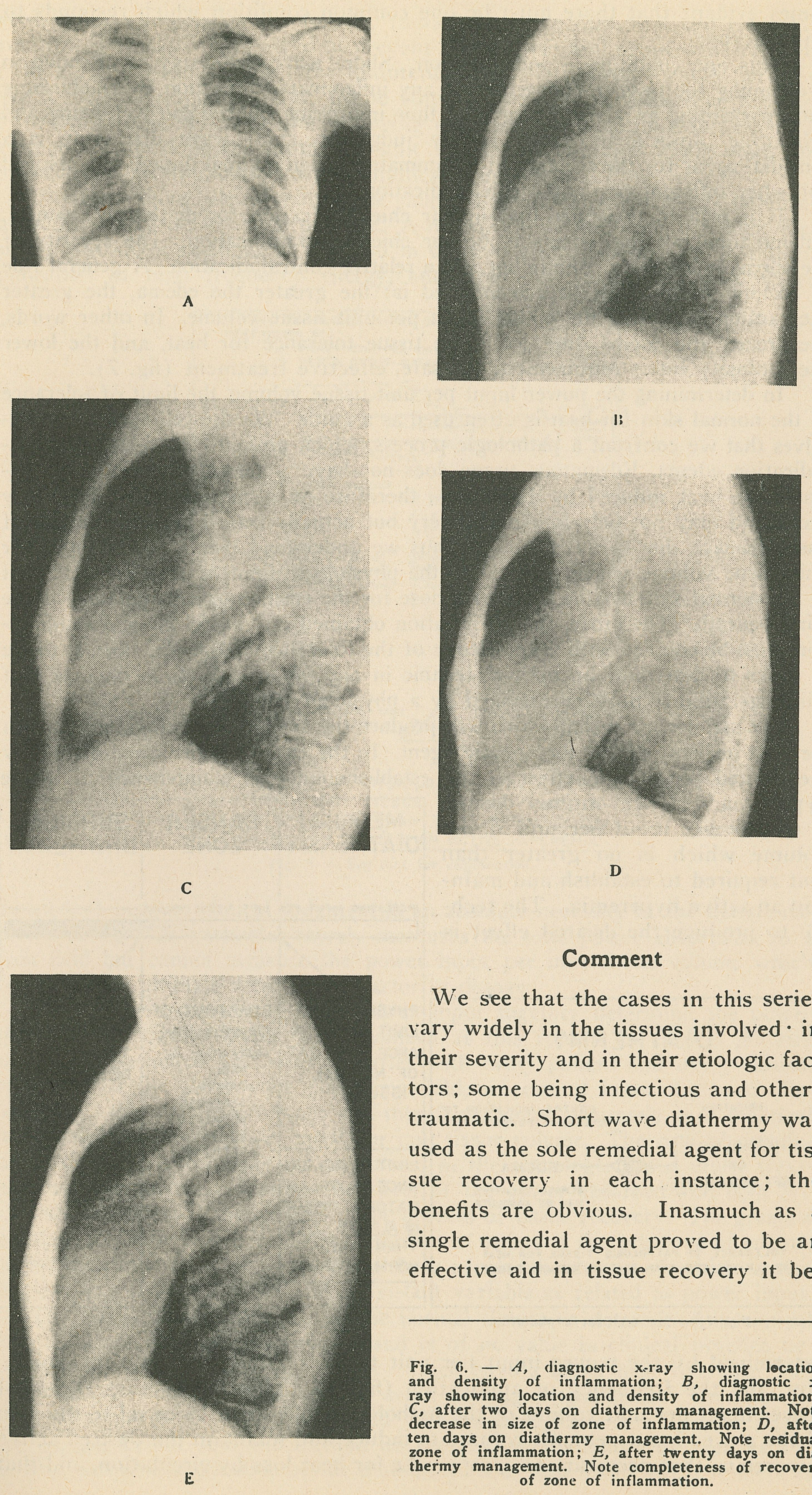


Fig. 6. — *A*, diagnostic x-ray showing location and density of inflammation; *B*, diagnostic x-ray showing location and density of inflammation; *C*, after two days on diathermy management. Note decrease in size of zone of inflammation; *D*, after ten days on diathermy management. Note residual zone of inflammation; *E*, after twenty days on diathermy management. Note completeness of recovery of zone of inflammation.

## Comment

We see that the cases in this series vary widely in the tissues involved in their severity and in their etiologic factors; some being infectious and others traumatic. Short wave diathermy was used as the sole remedial agent for tissue recovery in each instance; the benefits are obvious. Inasmuch as a single remedial agent proved to be an effective aid in tissue recovery it becomes evident that there must be one common condition which responds to this therapy.

This one condition is inflammation. Short wave diathermy is effective in overcoming the passive congestion of any inflammatory reaction by establishing and maintaining an active hyperemia, thus improving physiologic well-being and promoting physical recovery. In my judgment, short wave diathermy is a remedial agent for the reaction of inflammation when optimal dosage is employed and when inflammation is the chief indication.

It is well to recognize that in our chief indication for diathermy, namely, inflammation, we find edema to be our chief contraindication. The severity of the edema is always a definite but also a relative contraindication. A general rule of technic which must be remembered is: the greater the edema, the greater the caution regarding the power input per unit tissue volume. In other words, the greater the edema, the less is the tissue tolerance for heat, and the lower the intensity input requirement for safe, effective treatment (fig. 7).

In determining the power input per unit tissue volume, the limit of tolerance of the normal skin for heat is often used as a guide. We do well to remind ourselves that we confront a pathologic process, which presents the relative contraindication edema. Edematous tissue does not have a normal circulation to dissipate the heat induced by diathermy; therefore an accumulation of heat may occur and may not only hinder recovery but actually retard healing because of tissue damage due to overheating. Thus we understand that a power input per unit tissue volume which is equal to the physiologic limit of tolerance for heat of the normal skin may be a harmful dose for the edematous inflammatory tissue lying beneath. Therefore, the information obtained on careful clinical examination must be coupled with a knowledge of the tolerance dosage for normal tissue in order to determine an optimal technic in any given case. It is obvious that this responsibility must be assumed by a physician (fig. 8).

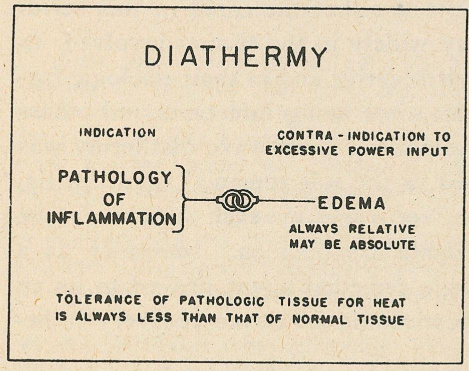

DIATHERMY
INDICATION
CONTRA-INDICATION TO EXCESSIVE POWER INPUT
PATHOLOGY OF INFLAMMATION
EDEMA
ALWAYS RELATIVE
MAY BE ABSOLUTE
TOLERANCE OF PATHOLOGIC TISSUE FOR HEAT IS ALWAYS LESS THAN THAT OF NORMAL TISSUE

Fig. 7. — See text for explanation.

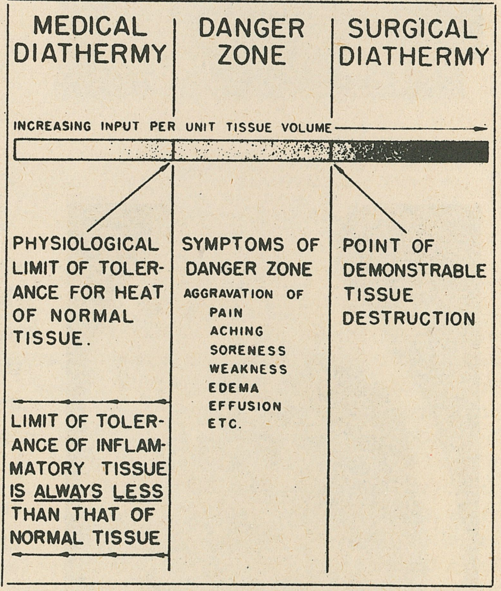

MEDICAL DIATHERMY
DANGER ZONE
SURGICAL DIATHERMY
INCREASING INPUT PER UNIT TISSUE VOLUME
PHYSIOLOGICAL LIMIT OF TOLERANCE FOR HEAT OF NORMAL TISSUE.
LIMIT OF TOLERANCE OF INFLAMMATORY TISSUE IS ALWAYS LESS THAN THAT OF NORMAL TISSUE
SYMPTOMS OF DANGER ZONE
AGGRAVATION OF
PAIN
ACHING
SORENESS
WEAKNESS
EDEMA
EFFUSION
ETC.
POINT OF DEMONSTRABLE TISSUE DESTRUCTION

Fig. 8. — See text for explanation.

Optimal dosage is that which will produce the desired physiologic effect with the least quantity of the therapeutic agent. In the case of short wave diathermy the desired physiologic effect is the establishment and maintenance of active hyperemia. Hence optimal dosage is that power input per unit tissue volume which is no greater than that required to establish and maintain an active hyperemia. The technic to produce the desired effect is determined by the power input per unit tissue volume, the time of application, and the frequency of application (fig. 9). This means that the total power input per unit volume of the pathologic zone must be equal to the sum of the power input per unit volume to induce and maintain the desired active hyperemia, that necessary to compensate for heat loss by circulation, and that necessary to compensate for loss by radiation, convection, and the evaporation of perspiration. Insulation to prevent loss of heat and proper distribution of the electrical input permit the maintenance of the desired local hyperemia with a minimal input per unit tissue volume and prevent excessive heating of the pathologic zone. In the following diagrams the relationships existing between the total power input per unit volume of the pathologic zone for various types of application are symbolically expressed.

Clinicians have been seeking some simple direct method of dosage determination for ready use in actual practice. A measuring device, such as a high frequency wattmeter is an invaluable aid in observing the exactness of a clinical application of high frequency energy, but cannot be used as a dose meter (dosimeter) because clinical judgment is an absolute necessity in the determination of dosage. A wattmeter merely measures the total power absorption in a given field but cannot measure the power input per unit tissue volume which after all is the ultimate determining factor in dosage.

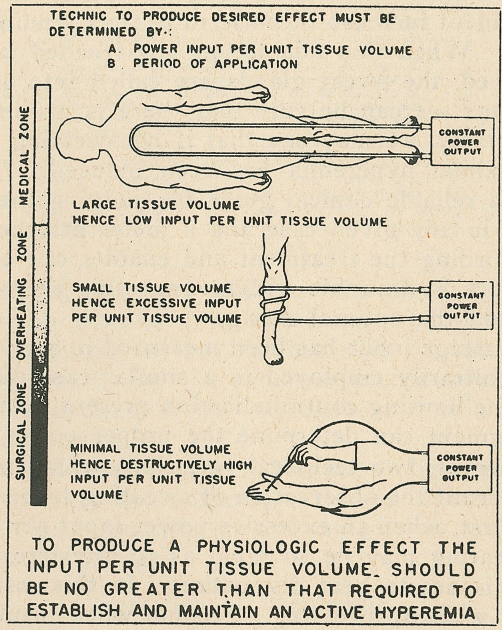

TECHNIC TO PRODUCE DESIRED EFFECT MUST BE DETERMINED BY:
A. POWER INPUT PER UNIT TISSUE VOLUME
B. PERIOD OF APPLICATION
MEDICAL ZONE
OVERHEATING ZONE
SURGICAL ZONE
CONSTANT POWER OUTPUT
LARGE TISSUE VOLUME HENCE LOW INPUT PER UNIT TISSUE VOLUME
SMALL TISSUE VOLUME HENCE EXCESSIVE INPUT PER UNIT TISSUE VOLUME
CONSTANT POWER OUTPUT
MINIMAL TISSUE VOLUME HENCE DESTRUCTIVELY HIGH INPUT PER UNIT TISSUE VOLUME
CONSTANT POWER OUTPUT
TO PRODUCE A PHYSIOLOGIC EFFECT THE INPUT PER UNIT TISSUE VOLUME SHOULD BE NO GREATER THAN THAT REQUIRED TO ESTABLISH AND MAINTAIN AN ACTIVE HYPEREMIA

Fig. 9. — See text for explanation.

Total tissue volume and total power input together determine the power input per unit tissue volume, but inasmuch as this volume in clinical practice cannot be determined, and since it varies with every patient and every clinical application of the short wave diathermy field, we cannot know the exact distribution of the total power input and therefore cannot accurately in a practical measure determine the power input per unit tissue volume. The rate of circulation in the body also cannot be determined in the pathologic tissue under treatment, but it definitely influences the effect of the power absorbed and both are in a state of continual change during the process of tissue recovery. The greatest limitation to power input from the viewpoint of safety is the presence of edema, and no inflammatory process is ever without edema, the degree of which is also an unknown, undeterminable, and inconstant variable as related to power input.

The actual temperature rise in the normal tissues as determined in clinical research is only a single observation and is of no value in clinical practice because we are treating pathologic tissues which have a lesser heat tolerance; because there is no method of clinical depth heating measurement; because the same temperature rise can be obtained with variable technics of power input, time of application, and the method of short wave diathermy as well as the physical technical application of the diathermy field; and finally because there is no evidence at hand to indicate any specific thermal action which would support the practice of elevating the tissue temperature to any certain degree.

Inasmuch as the pathologic condition demanding treatment is the sole determinant of dosage, and inasmuch as there are so many variables in the pathologic field treated; and as the hand of a technician adjusts dials and meter readings according to a prescription, it becomes increasingly clear that the basic determination of optimal dosage must be the result of expert clinical observation and judgment.

The physiologic effect desired may be judged by the observation of the objective changes in the tissues being treated. When heat is induced in the tissues nature's first response is a change favoring heat dissipation to prevent overheating. This causes an opening-up of the vascular bed and in many cases a coincident increase in pulse rate, thus tending to augment the rate of blood flow. When this adaptation has reached its limit and additional heat is induced, the sweat glands are called into action. Therefore, when sweating occurs we can be sure that there is maximal hyperemia beneath. And, conversely, we may say that if no sweating occurs we cannot be sure that a maximal hyperemia has been induced. The incidence of sweating, then, is a reliable clinical guide for judging the power input per unit tissue volume in any given case and a meter attached to the machine merely permits recording the treatment and enables one to repeat the same procedures when such is desirable without repeating the observations which originally determined the optimal dosage.

Even after a wattage input has been measured in a given case, this same input cannot be arbitrarily employed in a similar case due to the variance of the severity of the limiting contraindication present, namely, edema. Only expert clinical judgment can determine the proper power input.

There are, however, two technical variations which must be mentioned which would not permit the observation of sweating to be a reliable guide to optimal dosage. First, when an excessive power input per unit tissue volume is used, the overheating may be so rapid as to interfere with the normal adaptation in the tissues to heat dissipation. In this instance severe overheating may occur without sweating. Second, when insulation against heat loss is not used, mild sweating may be unobserved because the rate of evaporation equals that of sweat elimination. Thus moderate overheating continues throughout the treatment. Inasmuch as this is the greatest danger in the application of short wave diathermy, it is of utmost importance to avoid its occurrence.

Insulation against loss of heat and distribution of electrical input permit the maintenance of the desired local hyperemia with a minimal electrical input per unit tissue volume and prevent excessive heating of the pathologic zone. Figure 10 presents the reasons of technical advantage but there are also reasons of clinical advantage for so doing. The process of inflammation often produces associated inflammation or functional disturbances in contiguous tissues which are frequently regarded as of lesser importance. A good example of this may be seen in lobar pneumonia where there is a severe congestion of the non-pneumonic lung tissue. In such a case localization of the diathermy to the pneumonic lobe will not produce a satisfactory relief from cyanosis and dyspnea because the efficiency of pulmonary ventilation is not readily increased by the treatment. But when diathermy is applied to the non-pneumonic tissue as well, then the active hyperemia induced relieves the passive congestion in this non-pneumonic tissue and the cyanosis and dyspnea are quite promptly relieved. Pulmonary ventilation is sufficiently improved to permit increased, often adequate, oxygenation of the blood by breathing merely atmospheric air.

Another example of the value of treating tissues secondarily involved, and adjacent to a pathologic area is given in the following case. A patient with a non-union of the tibia and fibula, at the junction of the middle and lower thirds, of fifteen months duration volunteered the information after ten daily diathermy treatments that the toe nails on the foot distal to the fracture had not grown during the previous fifteen months and since the diathermy was being applied to the extremity the nails had grown sufficiently to require cutting.

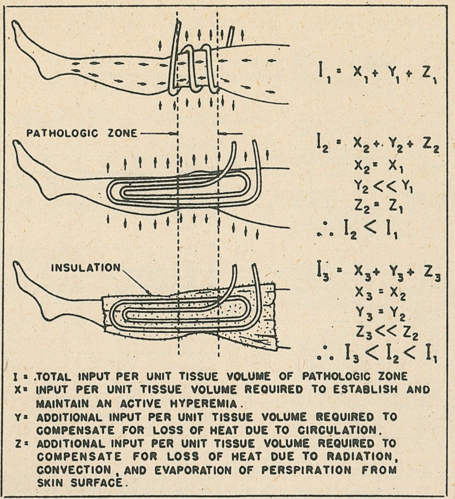

$I_1 = X_1 + Y_1 + Z_1$
PATHOLOGIC ZONE
$I_2 = X_2 + Y_2 + Z_2$
$X_2 = X_1$
$Y_2 << Y_1$
$Z_2 = Z_1$
$\therefore I_2 < I_1$
INSULATION
$I_3 = X_3 + Y_3 + Z_3$
$X_3 = X_2$
$Y_3 = Y_2$
$Z_3 << Z_2$
$\therefore I_3 < I_2 < I_1$
I = TOTAL INPUT PER UNIT TISSUE VOLUME OF PATHOLOGIC ZONE
X = INPUT PER UNIT TISSUE VOLUME REQUIRED TO ESTABLISH AND MAINTAIN AN ACTIVE HYPEREMIA.
Y = ADDITIONAL INPUT PER UNIT TISSUE VOLUME REQUIRED TO COMPENSATE FOR LOSS OF HEAT DUE TO CIRCULATION.
Z = ADDITIONAL INPUT PER UNIT TISSUE VOLUME REQUIRED TO COMPENSATE FOR LOSS OF HEAT DUE TO RADIATION, CONVECTION, AND EVAPORATION OF PERSPIRATION FROM SKIN SURFACE.

Fig. 10. — Diagrammatic representation of the influence of insulation and of the distribution of power input on the required power input per unit volume of tissue in the pathologic zone to induce and maintain an active hyperemia. For explanation of formula see text.

Thus we see that the distribution of the power input is not only a safety factor against overheating the pathologic tissues, but also is desirable in order to overcome the associated passive congestion and trophic changes occurring in contiguous tissues.

### Duration of Treatment

After having determined the power input of the short-wave diathermy to a pathologic zone it becomes necessary to establish how long this input should be continued for a single treatment and how often this procedure should be repeated. Inasmuch as a physiologic improvement is desired it becomes necessary to administer the therapeutic agent for such period of time and as often as is required to effect an accumulative benefit. Again, the decision rests upon careful clinical observation and judgment. Figure 11 presents conventional treatment schedules which are considered on a basis of the number of treatments per week. From this illustration it is clearly evident that the aggregate duration of the hours of induced active hyperemia is exceedingly small compared to the hours of no induced active hyperemia. There have been numerous examples in my experience with a treatment schedule in which a single application of short wave diathermy produced a transient improvement, but the pathologic process reverted to its original severity before the second treatment was given. In such instances accumulative benefit was either not evident or the improvement was so slow as to make the procedure economically unsound. When such failures in treatment were given short wave diathermy according to my treatment schedules as shown in figure 12 (a, b), recovery was satisfactory and surprisingly prompt.

Consider the fact that in the employment of short wave diathermy the therapeutic agent is heat. As long as there seem to be no specific advantages in the electric lines of force, in the wavelength, or in any specific thermal effect, we may divorce short wave diathermy from the expectancy

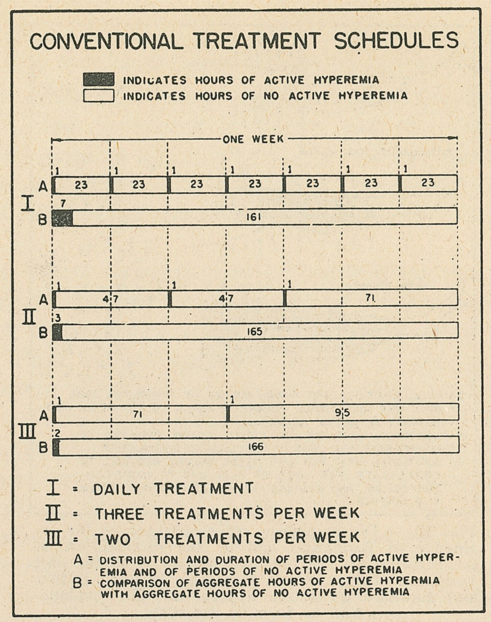
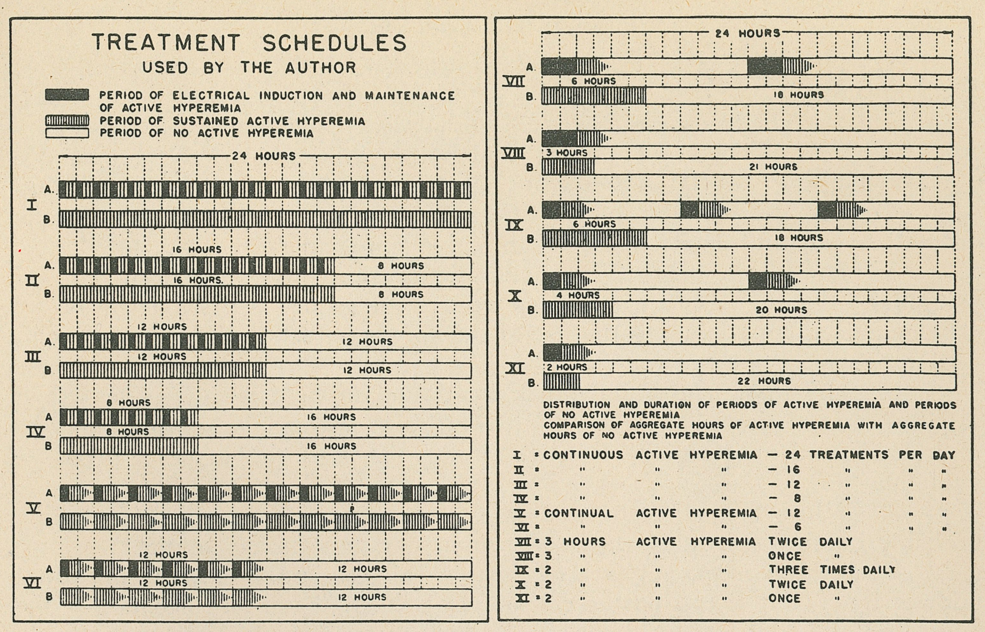


Fig. 11. — See text for explanation.

of any miracle and use it according to the rules governing the application of heat. The depth heating characteristic of short wave diathermy surely is of singular advantage but we nevertheless are applying the simple effective agent, namely, heat.

If this conventional schedule of treatment by diathermy is adequate, then likewise it should be quite satisfactory to apply heat by hot wet applications for one hour, two or three times weekly. A commonly accepted treatment for an infected extremity with lymphangitis is the continuous application of heat, by means of hot wet dressings, and in order to insure the safety and adequacy of the application we even justify the expense of twenty-four hour special nursing service. If this procedure is reasonable and desirable then there is just as much good sense in the use of short wave diathermy for the same purpose, namely, of applying heat. Short wave diathermy in such a case is superior to hot wet dressings; the hyperemia induced is more adequate at all times and furthermore there is no waterlogging of the skin to offer a handicap for rapid recovery. When an optimal power input to the pathologic tissues is employed, there is no contraindication to the maintenance of a continuous or a continual active hyperemia by the application of short wave diathermy. The cases presented in this article clearly testify in favor of the treatment schedule used by me as shown in figure 12 (a, b). The wide range of treatment schedules shown in this chart illustrates the varied adaptations used to meet the requirements of individual cases. The range of clinical application extends from the treatment of a severe threatening infection down to management of a mild ambulatory patient with a non-disabling complaint.

For this scheme of treatment which requires prolonged or frequent applications of short wave diathermy I have used the electromagnetic induction field for several reasons. First, on account of the physical adaptability of the cable to secure the desired distribution of the power input; and also its applicability to all anatomic parts. Second, on account of the established heating characteristics of the electromagnetic field, namely, dominant production of heat in the vascular tissues and the maintenance of the normal heat gradient from muscle, to fat, to skin. My work is done with a low power input in all cases. Total wattage input to the patient has been measured, recently, with a high frequency wattmeter for all of the various applications used. The total wattage input is low and varies widely according to application as shown in table 1.



A

B

Fig. 12, A and B. — See text for explanation.

Table 1. — *Total Power Input Measured With a High Frequency Wattmeter.*

| Treatment | Application | Watts |
|---|---|---|
| Head | 12″ Disc | 20- 35 |
| Chest | 12″ Disc | 35- 70 |
| Pelvis | 12″ Disc | 50- 75 |
| Back (Lumbar) | Pancake Coil (3 turns) | 45- 85 |
| Lower Extremity | Long Single Loop | 80-110 |

The measurements given in table 1 represent the total power input expressed in watts. These readings are measurements of my regular treatment technic. The total values are desirably low and when we estimate the tissue volume to which this total power input is distributed, we find a very small power input per unit tissue volume in all cases. The variation in wattage readings indicates the requirement of using different intensities according to the clinical judgment at the time of each treatment. It is important to note by this study that a constant dial reading on the diathermy machine gives different readings on the wattmeter according to the application of the electromagnetic field. For example, when applying the field to the lumbar region, the chest, the pelvis, the leg, each with the same dial setting on the apparatus, the wattmeter showed wattage readings of 44, 70, 58, and 86, respectively. Thus we see that the power input cannot be satisfactorily determined by the control dial reading alone, on any short wave apparatus, nor even by a high frequency wattmeter unless the distribution of the power input is taken into consideration and the severity of the pathologic process judged clinically. The optimal power input per unit tissue volume is secured by proper application of the induction cable and by adjustment of intensity to a value determined by clinical judgment. I have used the electromagnetic induction field in clinical research for the past five years and have adjusted and varied the intensity input on the basis of clinical judgment, using the lowest power input in each case which would produce a favorable result. Such individualization is amply rewarded by the results obtained.